

SECTION 16500

LIGHTING

PART 1 - GENERAL

0.1 DESCRIPTION OF WORK

- A.** Work Included: This Section specifies lighting systems, complete and operable, as indicated, including fixtures; fixture mounting hardware including brackets, canopies, hangers, and poles; lamps; auxiliary lighting equipment; and lighting control equipment.
1. The equipment and materials required under this Section shall be in accordance with the general description as indicated in Section 16050 - BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK.
 2. Lighting levels shall exceed code minimums for safety and security purposes.
 3. Light control panels to be located separately from Communication, Traction Substations, and Unit Substation rooms.
- B.** Related Work: The equipment and materials required under this Section shall be in accordance with the general description as indicated in Section 16050 - BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK.

0.2 SUBMITTALS

- A.** Submit shop drawings, catalog cuts, descriptive information and photometric data for all lighting fixtures, lamps, auxiliary lighting equipment, lighting control equipment, and mounting hardware.
- B.** Submit manufacturer's installation instructions.
- C.** If specified, before production is commenced, submit a sample fixture of each style, mounting and lamp arrangement specified. Reports indicating that required tests specified have been successfully completed shall accompany each pre-production sample at the time it is submitted. The sample, if approved, will be retained until completion of the work to confirm quality conformance to the prescribed requirements herein. Provide the sample for operation at 120 volts with six-foot cord and plug.
- D.** Sample for finishes and colors:
1. Submit samples for acceptance showing nominal color(s) and gloss, and the high and low color and gloss range(s) within which the production materials will be processed.
 2. Identify samples as to alloy, pretreatment and color.

3. Hold Point. Do not begin processing of production materials until Engineer's written approval of samples has been obtained.
4. Maintain variation in color of installed materials to the color range established by the acceptance samples.

0.3 QUALITY ASSURANCE

- A. Fixtures and auxiliary equipment shall be listed, labeled or certified by UL.
- B. Replace lamps, which fail within 90 days after final acceptance, at no cost to the Owner.
- C. Installation Tolerances: Deviation from location, alignment and mounting height: 1/2 inch noncumulative in any unit or continuous run of fixtures.

PART 2 - PRODUCTS

0.1 LIGHTING FIXTURES

A. General Requirements

1. Provide lighting fixtures, complete and ready for service, in compliance with UL 57, of the number, type, material, finish, electrical components and characteristics, and with all necessary hardware and auxiliary equipment indicated.
2. The fixtures shall be clearly marked with manufacturer's name and catalog number, voltage, acceptable lamp type, maximum wattage, ballast type, and self-protection, if any.
3. Fixtures shall be rain-tight and dust-tight for use along trackways, for outdoor use, and as indicated. Fixtures must meet IP55 test for water and dust.
4. Minimize the type and variety of fixtures to be provided.
5. For AC, prefer the use of low mercury fluorescent, high output, 8 foot, T 12 lamp, 277 volt, magnetic ballast, 2 lamp, -20 F to 90 F fixture. (Lithonia DMW 96 HO, Simkar OV410296HO277V, Eastern VT296HO)
6. For DC, prefer 3 lamp, 600 volts, 24 inch length 17 watts, low smoke fixture, clear hinged lense metal frame wet location with 600 VDC rated in line fuse and externally mounted switch. (L.C. Doane M3-17-3-600VDC-LSA-FH).

B. Materials

1. Thicknesses, gauges and tempers of products: indicated, and as recommended by the manufacturer for the specific finish, proper forming operations and structural requirements.
2. Lighting sheet for reflector material: Prefinished aluminum, minimum thickness 0.032 inch, architectural Type 1 with Class M1, anodic coating providing 83% reflectively.

3. Concrete for base foundations: Section 03300 - CAST-IN-PLACE CONCRETE
4. Acrylic lenses: 100% virgin acrylic plastic.
5. Polycarbonate lenses and diffusers: Injection molded, crystal clear material, polycarbonate.
6. Lenses to be clipped and hinged.

C. Finishes

1. Finishes shall be in accordance with the manufacturer's recommendations for the specific application.
2. Commence no finishing operations until fabrication and forming operations have been completed.
3. Aluminum work to be anodized shall be given a preanodic treatment followed by an architectural Class 1, anodic coating as described by the Aluminum Association.
 - a. Anodize aluminum in accordance with procedures established by alloy manufacturer to achieve color within specified range.
 - b. Apply a clear organic protective coating to exposed aluminum surfaces that may experience prolonged contact with caustic material, i.e., concrete, plaster.
4. Baked enamel: Factory applied to clean surfaces prepared with a chromate conversion coating, and prime coating, as indicated.
5. Porcelain enamel coating: In accordance with the requirements of Porcelain Enamel Institute, PEI-S-100.
6. Galvanized coating: Hot-dip galvanized or hot-zinc conforming to ASTM A 386. Where painting of the galvanized surface is indicated, prepare the surface with vinyl acid wash primer with polyvinyl butyral resin 56 pounds, 80 gallons zinc chromate pigment and phosphoric acid.

D. Electrical Components

1. Lampholders
 - a. Lampholders and sockets: Class and style recommended by the lamp manufacturer for the specified lamp required by each fixture design and rated for 660 watts, 600 volts or as indicated. Rigidly and securely fastened to the mounting surfaced with the necessary provisions to prevent lampholder from turning and front removable without dismantling any part of the fixture. Located in the lighting fixtures to place each lamp, of size specified, in proper position with relation to the fixture design specified. Clearly marked to indicate manufacturer lamp type and voltage and appropriate listings.
 - b. Incandescent and high intensity discharge (HID) lampholders: Glazed porcelain body with nonferrous metal components of heavy duty design, vibration resistant, Edison-based lampholders in accordance with the applicable requirements of UL 496.
 - 1) General purpose incandescent lamps: Medium screw base socket.

- 2) Incandescent mogul base lamps of PAR configuration: Mogul end prong base socket rated 1000 watts, 125 volts.
 - 3) Special low wattage incandescent lamps such as the 20-watt T6-1/2: Phenolic bodied DC bayonet socket rated 75 watts, 125 volts.
 - 4) Single ended tungsten-halogen lamps: Minican screw socket.
 - 5) Double ended tungsten-halogen lamps: Recessed contact socket rated 3000 watts, 600 volts.
 - 6) Mercury lamps of the B, R or PAR configuration up to 175 watts: Medium screw base socket.
 - 7) Mercury or metal halide lamps that are to be operated in the horizontal position: Position oriented mogul base socket.
 - 8) High pressure sodium lamps up to and including 1000 watts: High voltage mogul lampholder, 5Kv pulse rated, 1500 watts, 600 volts.
 - c. Fluorescent lamp holders: White urea, spring loaded with silver-plated contacts of the pedestal or butt-on type, in accordance with the applicable requirements of UL 542.
 - 1) Rapid start (430Ma) lamps: Medium bipin spring loaded lampholders of the tombstone or butt configuration.
 - 2) Rapid start (800 and 1500Ma) lamps: Recessed double contact lampholders of the telescopic type.
 - 3) Instant start, slimline lamps: Single pin lampholder of the telescopic type.
2. Ballasts
- a. Ensure ballast operating characteristics comply with the recommendations of the lamp manufacturer with regard to lamp electrical characteristics. Provide ballasts suitable for the line voltage with 0.9 power factor, and maximum current crest factor of 1.8. The ballast shall provide reliable lamp starting at the minimum temperature indicated, and operate in ambient temperatures up to 105°C with maximum ballast case temperature of 90°C. Each ballast shall be securely mounted inside the fixture, in such a manner as to obtain the necessary heat dissipation. High intensity discharge ballasts shall conform to the applicable requirements of UL 1029. Fluorescent ballasts shall conform to the applicable requirements of UL 935.
 - b. Mercury lamps: Operated by a constant wattage autotransformer, CWA, type ballast. The ballast shall provide reliable single lamp starting at minus 20°F, and allow plus or minus five percent lamp watts variation for a plus or minus 10 percent input voltage variation.
 - c. Metal halide lamps: Operated by a lead peaked auto, LPA, type ballast. The ballast shall provide reliable single lamp starting at minus 20°F, and allow plus or minus 10 percent lamp watts variation for a plus or minus 10 percent input voltage variation.
 - d. High pressure sodium lamps 150 watt size and smaller: Operated by a constant wattage autotransformer, CWA type

ballast. The ballast shall provide reliable lamp starting at minus 20°F, and allow plus or minus 5 percent lamp watts variation for a plus or minus 10 percent input voltage variation.

- e. High pressure sodium lamps, 250 watt size and larger: Operated by a constant wattage autotransformer, CWA type ballast. The ballast shall provide reliable lamp starting at minus 20°F, and allow plus or minus five percent lamp watts variation for a plus or minus ten percent input voltage variation.
 - f. Rapid start, 430 Ma, fluorescent lamps: Operated by a Class P, 430 Ma, 60 hertz ballast. The ballast shall provide reliable lamp starting at 0°F, and shall be provided with a sound level rating of 'A'. Lamp voltage variation shall not exceed plus five percent and minus 10 percent.
 - g. Rapid start, 800 Ma, high output fluorescent lamps: Operated by a Class P, 800 Ma, 60 hertz ballast. The ballast shall provide reliable lamp starting at minus 20°F, and shall be provided with sound level rating of 'B' or better. Lamp voltage variation shall not exceed plus five percent and minus 10 percent.
 - h. Rapid start, 1500 Ma fluorescent lamps: Operated by a Class P, 1500 Ma, 60 hertz ballast. The ballast shall provide reliable lamp starting at minus 20°F, and be provided a sound level rating of D or better. Lamp voltage variation shall not exceed plus five percent and minus 10 percent.
 - i. Slimline and instant start lamps: Operated by a Class P, 425 Ma, 60 hertz ballast. The ballast shall provide reliable lamp starting at 0°F and shall be provided with a sound level rating of "B" or better. Lamp voltage variation shall not exceed plus five percent and minus 10 percent.
 - j. Radio interference filter shall be provided as indicated.
 - k. All ballasts to be magnetic not electronic due to interference caused by traction power sources.
 - l. One light fixture per ballast.
 - m. Avoid the use of remote ballasts.
3. Fixture Wiring
- a. Fixture Wires: Stranded tinned-copper construction, not smaller than No. 16 AWG. Insulation: silicone rubber type SF-2 and 200°C rated. Conductor size, temperature rating, voltage rating and manufacturer clearly marked on the insulation of each conductor.
 - b. Use wires between lampholders and associated operating and starting equipment of the same ampacity rating as leads from the ballast. Wiring within the fixtures shall conform to the requirements of the NEC.
 - c. Tape wires at all points of abrasion. No splices shall be permitted within fixtures other than as required to connect lampholders and ballasts.
 - d. Fixture Grounding. Unless otherwise specified, the housing of each ballasted lighting fixture shall be provided with a separate, factory-installed grounding device. The grounding device is to

be used for connecting a separate, green, grounding conductor to the fixture housing.

- e. Wireways and wiring channels shall have rounded edges or bushed holes wherever conductors pass through. Insulated bushings shall be installed at points of entrance and exit of wiring.

E. Fixture Hardware

1. Latch and release mechanism, hinges, pins and other retaining parts of fixtures; screws, bolts or other assembly and mounting parts: manufactured of Type 316 stainless steel. All springs: heavy duty stainless steel. All retaining hardware: self-retaining.
2. Frame light transmitting elements of the fixture to permit replacement of panels in the frames without the use of tools other than screwdriver or pliers. Secure panels in the frames in a neat, rattle-free manner that will provide proper tolerance for normal expansion and contraction.
3. Provide stems for all pendant mounted fixtures of length as required for the specified mounting height with swivel hangers or ball aligners as required.
4. Form gaskets, sealants and adhesives subjected to high temperature from silicone rubber. Provide other gaskets of neoprene, or as indicated.
5. Fasteners: Provide bolts, nuts, washers, screws, nails, rivets and other fastenings necessary for proper erection or assembly of work. When exposed to the atmosphere, provide fasteners made of 18-8 stainless steel. Fasteners within the housing shall be made of zinc plated, bright iridite, steel or electrogalvanized, gray. Nuts shall have captive externally footed lockwashers.

F. Welding

1. Locate welds in assemblies to be anodized to conceal visible discoloration in the heat-affected zone.
2. Where weld metal will be exposed after anodizing, select filler alloys to closely match composition of base metal. Comply with parent metal manufacturer's recommendations for such filler alloys.

0.2 FIXTURE MOUNTING HARDWARE

- A.** General Requirements. Provide the fixtures with brackets, straps, canopies and stems, poles and miscellaneous hardware suitable for the mounting method specified.
- B.** Secure mounting brackets to housing, quantity and spacing as indicated. When exposed to public view, fabricate and finish hardware in matching material to fixture body. Fabricate internal brackets from sheet steel, zinc coated after fabrication.

- C. Canopies, holders and similar parts shall be drawn or spun in one piece with a minimum 0.026 inch finished thickness.
- D. Tubing used for supporting member shall be seamless drawn with a minimum of 1/16 inch wall thickness of size and length as indicted.
- E. Light poles. Of the type, configuration and dimensions, indicated. The pole shall resist wind loads of 90 mph with a maximum deflection of five percent when fully loaded by their own weight, weight and wind resistance of luminaires they support, and any externally applied loads. Furnish poles as indicated with four by six inch handhole with flushcover, luminaire mounting (tenon/bracket), base cover and all mounting hardware including anchor bolts, nuts, washers and baseplate to permit accurate alignment and installation of pole and luminaire as indicated. All wiring splices to be located above ground. All exterior light poles to have a minimum 30 inch concrete base for protection from snow plows.

0.3 LAMPS

- A. General Requirements. Provide each lighting fixture with the number, type, and wattage of lamps required by the Contract Drawings. Provide lamps of standard manufacture, readily available, and of the highest efficiency and life consistent with other requirements of the illumination system.
- B. Incandescent Lamps: Rated for 120 volts, unless otherwise specified, and minimum 2000 hours life.
- C. Fluorescent Lamps: Wattage and types as indicated, with warm white color.
- D. Mercury Lamps: Color, white deluxe. Reflector face, if required, clear.
- E. Metal Halide Lamps: Clear and provided with position oriented mogul bases. Photometric characteristics shall provide lamp maximum luminous output while lamp operates in the vertical position.
- F. High Pressure Sodium Lamps: Clear and suitable for specified operating positions (base up or base down).

0.4 AUXILIARY LIGHTING EQUIPMENT

- A. General Requirements. Auxiliary lighting equipment intended to supply illumination in the event of failure of normal power supply: Conform to the applicable requirements of UL924, NEC, MBTA Life Safety Code, NFPA-101, Massachusetts State Building Code, and the Massachusetts Electrical Code.

- B.** Unitized battery packs mounted integral with fluorescent fixtures shall energize upon failure of normal power and shall provide approximately the constant light output delivered under normal power operation, for a period not less than 90 minutes. The unit shall contain a transistorized inverter ballast, a transfer relay and associated circuitry, a battery charger and batteries of nickel-cadmium. In addition, a test button and derangements signal light shall be provided to monitor the charging function.
- C.** Battery packs mounted remote from luminaires: Conform to the applicable requirements of UL 924. The battery-powered source shall provide continuous power to lighting loads, consisting of any mix of HID, fluorescent, or incandescent lamps. During short power interruptions, brownout conditions or a total lapse of normal AC power, it shall supply the full rated load at both 120 and 277 volts for ninety minutes to a minimum voltage level of 87-1/2% of nominal voltage.

0.5 LIGHTING CONTROL EQUIPMENT

- A.** General Requirements. Provide lighting control components suitable for the lighting system specified and compatible for interface with other associated control devices. Lighting control components shall be rated for continuous service and operate satisfactorily in every respect while the branch circuit power supply voltage to each system is within a 105 to 130 volt range at 60 hertz. Electrical contacts shall have precious metal surfaces.
- B.** Lighting Contactors
 - 1. Conform to the applicable requirements of UL 508.
 - 2. Electrically operated and mechanically held.
 - 3. Rated at 600 volts, 60 hertz with ampere rating, number of poles and enclosure as indicated.
- C.** Lighting Relays
 - 1. Conform to the applicable requirement of UL 508.
 - 2. Electrically operated and mechanically held.
 - 3. Rated at 600 volts, 60 hertz, 25 amperes with number of poles and enclosure as indicated.
- D.** Time Switches
 - 1. Conform to the applicable requirements of UL 887.
 - 2. Pre-wired with astronomic dial, 36-hour synchronous reserve power motor.
 - 3. Manual on-auto-off bypass switches for up to three individual circuits.
 - 4. Rated at 277 volts, 60 hertz, 40 amperes continuous duty with number of poles, throws and enclosure as rated.
- E.** Photoelectric Sensor

1. Conform to the applicable requirements of UL 773.
2. Operation in temperature range of minus 50°C to plus 60°C.
3. Dusk to dawn operation with adjustments from two to 50 foot candles with a five-second time delay to preclude false switching.
4. Weatherproof and tamperproof.
5. Acceptable for operation from a supply voltage range of 105 to 285 volts AC.
6. Rated for a lamp load of 1000 watts of incandescent lighting; 1800 va of mercury vapor, fluorescent, or high-pressure sodium lighting.
7. Minimum life at rated load: 8000 on-off operations.
8. Provided with three blade, twist lock polarized plug and receptacle.
9. Photoelectric sensors shall be mounted facing a northerly direction.
10. 1Photoelectric sensors, upon failure, shall default to the "on lighting" position.

F. Light Intensity Controls

1. Enclosed, automatic or manually, continuously-adjustable, and completely solid state for the control voltage and rated load indicted.
2. Incandescent systems.
3. Fluorescent systems.
4. HID systems.

G. Wall Switches

1. Fed. Spec. W-S-896, types II and III. Switches installed in hazardous areas: Explosion-proof type in accordance with the NEC and as indicated.
2. Switches: Single unit, toggle, butt contact, quiet type with an integral mounting strap.
3. Wall switches for remote control: Momentary contact type suitable for mounting in a single gang outlet box space and compatible with standard design wall plates.
4. Switch Ratings
 - a. For 120 volt circuits: 20 amperes at 120 volts AC.
 - b. For 277 volt circuits: 20 amperes at 277 volts AC.
5. Switches shall be connected to the wiring with screw clamp type terminals.
6. Wall Plates
 - a. Type 304 stainless steel
 - b. Standard designs so the products of different manufacturers will be interchangeable.
 - c. Where switches are mounted adjacent to each other, the plates shall be common for each of the groups of switches.
7. Incorporate barriers between switches within multigang outlet boxes where required by the NEC.

PART 3 - EXECUTION

0.1 LIGHTING FIXTURES

- A.** Install lighting fixtures in accordance with the manufacturer's instructions, complete with lamps, hangers, brackets, poles, fittings, and accessories, ready for operation as indicated. Align, mount and level the lighting fixtures uniformly.
- B.** Avoid interference with and provide clearance for equipment. Where the indicated locations for the lighting fixtures conflict with the locations for equipment, change the locations for the lighting fixtures by the minimum distances necessary as approved by the Engineer.
- C.** For suspended lighting fixtures, the mounting heights shall provide the clearances between the bottoms of the fixtures and the finished floors as indicated. Chains shall not be used for suspension of fixtures.
- D.** Lighting fixture supports shall provide support for all the fixtures. Anchor supports to the structural slab or to structural members as indicated. Supports shall maintain the fixture positions after cleaning and relamping.
- E.** Surface mounted lighting fixtures shall be bracketed rigidly from the mounting surfaces. Provide a 1/4-inch clearance between surfaces when the fixture is flat mounted against concrete surfaces. Nipples carrying wire between fixtures shall be watertight.
- F.** Exterior fixtures mounted on block or brick walls shall be supporting anchor devices of the expansive lead type. No power driven anchors will be acceptable.
- G.** Where aluminum is placed in contact with dissimilar materials, except galvanized steel, zinc or stainless steel, treat contact surfaces as follows:
 - 1. When in contact with dissimilar metals, apply a prime coat of zinc chromate primer followed by two coats of aluminum and masonry paint.
 - 2. When in contact with concrete, masonry and plaster, apply to aluminum contact surfaces zinc chromate primer, bituminous paint, aluminum metal and masonry paint or pressure tape.
 - 3. When in contact with wood or other absorptive materials, apply two coats of aluminum house paint to such materials and protect aluminum contact surfaces with bituminous paint.
- H.** Provide pendant fixtures with swivel hangers to assure a plumb installation and have a minimum 25° swing from horizontal in all directions. Single unit suspended fluorescent fixtures shall have twin stem hangers. Multiple unit or continuous units shall have a tubing or stem for wiring at one point and tubing provided for each unit length of chassis including one at each end. Tubing shall not be less than 3/16 inch in diameter. Motion of swivels

or hinged joints shall not cause sharp bends in conductors or damage to insulation. For heavy pendant mounted fixtures, where support independent of box is required and where conduit and outlet boxes are installed on surface, provide safety swivel hangers with fixture studs.

- I. Install fixtures to be pole mounted in accordance with the manufacturer's recommended installation practices as indicated.
- J. Provide required lamps in each lighting fixture as soon as fixtures are properly installed.

0.2 BALLASTS

- A. Install ballasts, other than those mounted integrally within luminaires, as indicated, and in such a manner that the ballast is protected from weather, moisture, and other atmospheric conditions, and in such a manner that ambient temperature surrounding the ballast will not cause the temperature of the ballast housing hot spot to exceed UL requirements. Voltage drop to lamp, due to remote mounting shall not exceed one percent of the nominal lamp voltage. Secondary ballast conductors for high pressure sodium lamps shall have 1000-volt, high temperature insulation. When more than one ballast is mounted at one location, the minimum spacing between ballasts shall be 6 inches in a horizontal direction and 12 inches in a vertical direction.

0.3 LIGHT POLES

- A. Install light poles in accordance with the manufacturer's recommended installation practices as indicated.

0.4 CONCRETE BASES

- A. Obtain necessary templates and anchor kits before starting work.

0.5 AUXILIARY LIGHTING EQUIPMENT

- A. Install as indicated and in accordance with manufacturer's instructions.
- B. Anchor firmly in place.
- C. Test and adjust for proper operation in accordance with the manufacturer's instructions.

0.6 LIGHTING CONTROL DEVICES

- A.** Install lighting control devices in accordance with the manufacturer's recommended installation practices, and as indicated.
- B.** Where indicated, incorporate the components in panelboards behind separate doors and mount them on sound absorbing materials.
- C.** Install circuit breaker or fuse protection for the control circuits.
- D.** Mount the switches on the strike plate side of the doors.

0.7 FIELD QUALITY CONTROL AND INSPECTION

- A.** Inspect luminaires, lamps and associated hardware prior to and after installation to confirm that they are of the quality and type as specified herein and as indicated, and are free of defects and damage.
- B.** Provide luminaires and lighting equipment to the project site complete, with suspension accessories, canopies, hickey, castings, sockets, holders, reflectors, ballasts, diffusing materials, louvers, frames, recessing boxes, and related items, completely wired and assembled as indicated.
- C.** Whenever practicable, test lighting systems at the same time that the distribution panelboard or switchboard is tested.
- D.** Adjust floodlights in accordance with the aiming chart provided by the manufacturer. Make adjustments during darkness to obtain the optimum lighting levels throughout.

PART 4 - MEASUREMENT AND PAYMENT

0.1 MEASUREMENT

- A.** Lighting fixtures will be measured as per each complete in place, including all preparation, accessories and incidentals.

0.2 PAYMENT

- A.** Payment for lighting fixtures will be made at the Contract unit price for the quantities as specified above.

0.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
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1640.008 LIGHTING FIXTURES EA

END OF SECTION